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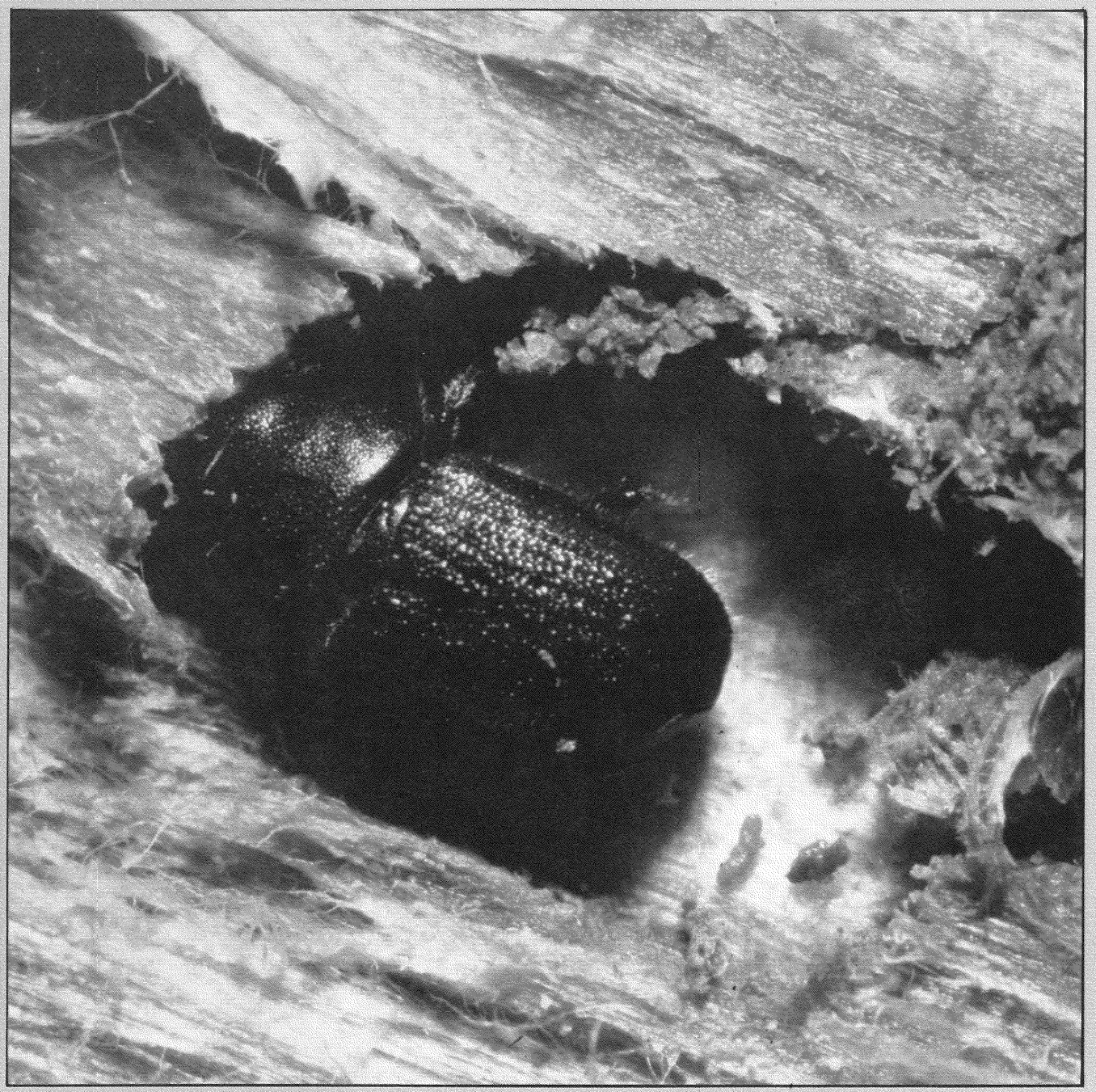
United States
Department of
Agriculture

**Forest Service**

# Forestry Research West

November 1991



A report for land managers on recent developments in forestry research at the four western Experiment Stations of the Forest Service, U.S. Department of Agriculture.

# Forestry Research West

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## Cover

A female spruce beetle deposits eggs on a white spruce. Scientists with the Pacific Northwest Station are conducting pheromone research in Alaska to develop strategies for reducing insect damage. Details begin on page 12.

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## Western Forest Experiment Stations

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Pacific Southwest Research Station (PSW)
P.O. Box 245
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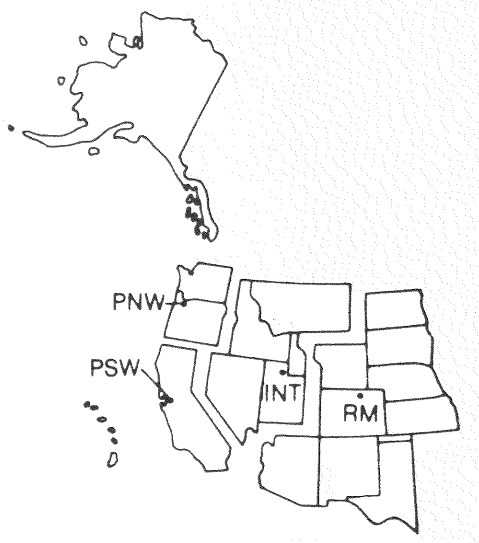
Intermountain Research Station (INT)
324 25th Street
Ogden, Utah 84401

Rocky Mountain Forest and Range Experiment Station (RM)
240 West Prospect Street
Fort Collins, Colorado 80526-2098



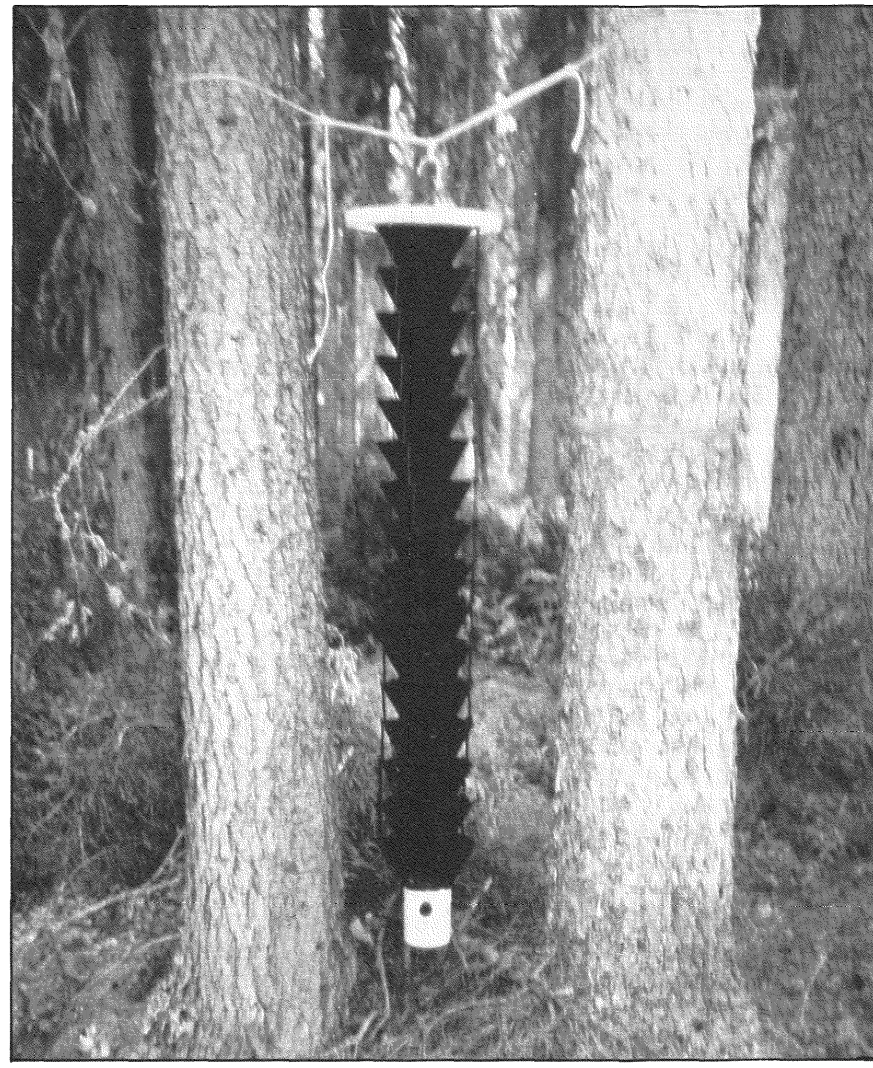
# Spruce beetle pheromone research in Alaska

by Sherri Richardson
Pacific Northwest Station

As a boy growing up on a farm in a small Pennsylvania town, Richard "Skeeter" Werner would closely observe the habits of bees and hornets—he was fascinated by insect behavior. Today, Werner, a 30-year veteran in the field of entomology, is Supervisory Research Entomologist at the Pacific Northwest Research Station's Institute of Northern Forestry in Fairbanks, Alaska. He is also lead scientist for a pheromone research project in cooperation with Region 10 Forest Pest Management entomologists. The research is targeted to develop strategies to manipulate populations of spruce beetles in order to reduce damage inflicted on thousands of spruce trees each year in south-central and interior Alaska.

"The death of individual trees and entire stands represents large annual losses in forest productivity, recreation and esthetic values, and wildlife habitat," Werner says. "Another danger is that beetle-killed timber increases fuel loads within stands which, in turn, increases the risk of a catastrophic wildfire."

Pheromones are chemical substances secreted by insects that influence the behavior of members of the same species. Pheromones are located in the digestive track of bark beetles. They are released in frass which is the woody boring material the beetle produces while eating. Synthetic bark beetle pheromone has an odor like turpentine.



*Lindgren funnel trap used to trap bark beetles. The trap is baited with spruce beetle.*

"Pheromones are used by insects as a sexual attractant for reproduction, but they can also signify aggregation (gathering together) nor feeding," Werner explains.

"Our research seeks ways to use pheromones to manipulate the behavior of the beetles, thereby saving the trees. We are trying to find alternatives to insecticides. And, so far, pheromones seem to be the way to go."

The spruce bark beetle is a major killer of spruce. The beetle attacks trees across Canada and from the southern Rocky Mountains to Alaska. During the last 15 years, more than 1 million acres of spruce in Alaska were infested. Since 1974, beetle populations have expanded throughout south-central Alaska from the Kenai Peninsula including the Chugach National Forest and Kenai National Wildlife Refuge. The beetles have also found their way to the west side of Cook Inlet in the Beluga-Tyonek area and north to Judd Lake.

"Much of the loss has occurred in areas with high-value trees such as campgrounds, recreational areas, hiking trail systems, and urban areas of small communities," Werner says.

Collaborating with Werner on the research are Edward Holsten, an Entomologist for Region 10 Forest Pest Management, State & Private Forestry; and Patrick Shea, Research Entomologist for the Pacific Southwest Forest and Range Experiment Station in Berkeley, California.

## The problem

"Endemic levels of spruce beetles can be found in almost any spruce stand in Alaska," Werner says. "The general progression for development of an outbreak would start with the attack of a few 'focus' trees."

Stressed, slow-growing trees are most likely to fall prey to the beetle attack. According to Werner, these trees then act as sites for population increases that allow the beetles to reach epidemic levels. A new brood of adult beetles emerges from the focus trees and attack the adjacent slower growing, less vigorous trees.

Stressed trees are the most prevalent host for the spruce beetle. What factors contribute to stressed conditions?

- Lack of silviculture management in over-stocked stands of slow-growing, mature, spruce trees.
- Stress on residual stands in the fringe areas of wildfire areas partially burned or damaged by smoke.
- Periodic flooding and deposition of silt on the forest floor.
- Poor utilization of felled trees and accumulation of slash following logging, rights-of-way construction, and windthrown trees.

## Three components of the research

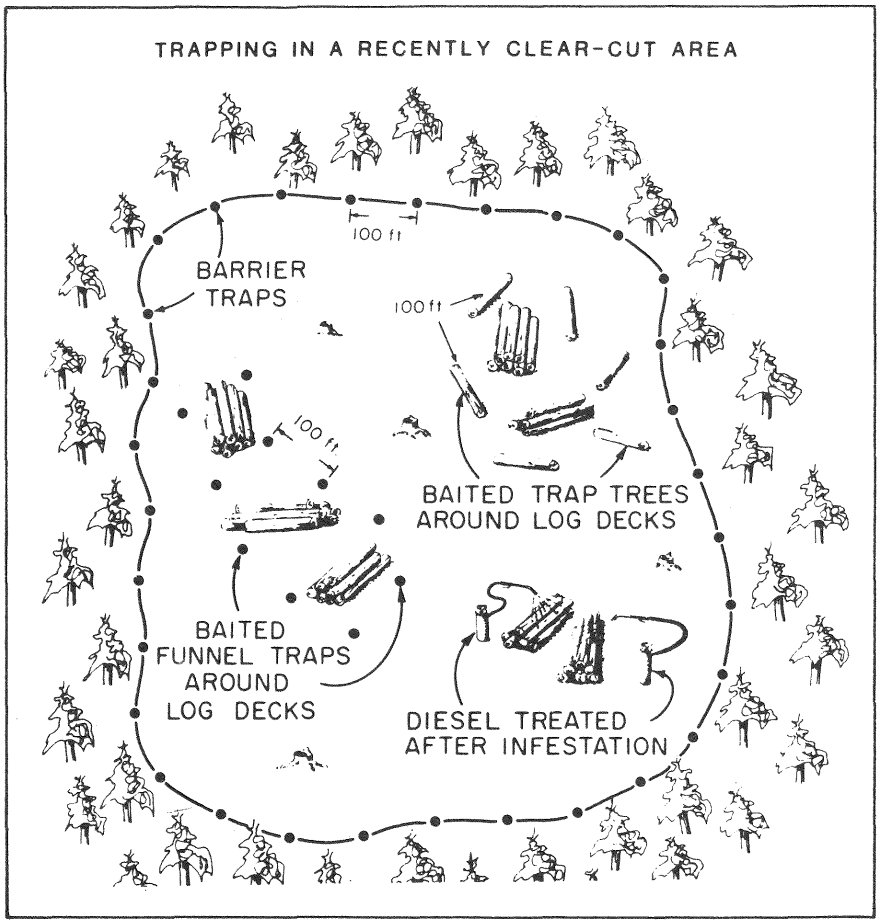
Werner's pheromone research has three major goals:

- Determine the role of bark beetle pheromones (from a variety of species) in providing competition for the spruce beetle in spruce trees in Alaska.
- Determine the effectiveness of ground and aerial application of methycyclohexenol or MCH (a spruce beetle antiaggregation pheromone).
- To develop a 5-year plan to study field testing of spruce beetle aggregation pheromone, and to produce applied technology for using pheromones.

## Use of bark beetle pheromones

"Past outbreaks in south-central Alaska have been associated with warm, dry summers and an accumulation of spruce debris from windthrown and felled trees that are highly productive breeding sites for spruce beetles," Werner explains. "When beetle populations increase and a sufficient supply of breeding material is no longer available for colonization, beetles can infest nearby living trees, particularly in mature stands."

Stand manipulation or the use of chemical insecticides has been the standard way to control beetle infestation. Werner and his colleagues have been examining alternatives to insecticides. Other classic techniques for treatment of logging slash, felled, or windthrown green trees is the immediate salvage of the trees. These trees are also disposed of by burning, chipping, or burying them. The use of Environmental Protection Agency (EPA) approved insecticides or pheromone-baited traps has also been successful in areas with high value stands.




*Use of baited trap trees and funnel traps to trap out spruce beetles in a recent clear cut.*

An innovative technique used to combat the beetle infestations are the use of semiochemicals. Semiochemicals are used to manipulate bark beetle populations and include synthetic host-produced chemicals and pheromones that prevent attack or reduce the attack density of bark beetles to a level below the threshold density required for the development of brood trees.

Werner says this technique has several advantages. "First, the use of insecticides would be minimal. Secondly, beetle resistance to treatment would be negligible since several different pheromones from competing species of bark beetles can usually be used," he says. "And finally, there would be little direct mortality to parasites and predators as occurs with insecticide treatment."

"Field studies conducted in south-central and interior Alaska during the last 10 years were designed to determine the attractiveness of several scolytid (family name of all bark beetles) pheromones and host terpenes (chemicals in trees that attract bark beetles) to the spruce bark beetle," Werner says.

Werner and his colleagues discovered that seudenol + alpha pinene (host terpenes) dispersed from funnel or sticky traps attracted more beetles than frontalin + alpha pinene. But frontalin, when applied directly on uninfested white and Lutz spruce trees, attracted more beetles than the seudenol-alpha pinene combination.

"Host suitability is also a major factor in attracting spruce beetles to host material," Werner adds. "When white spruce is infested with spruce beetle brood, more spruce beetles are produced than when Lutz or Sitka spruce are infested. In spite of host suitability differences, spruce beetle outbreaks have been more frequent and severe in Lutz spruce."

## Application of MCH

The use of MCH is being studied to reduce tree mortality by spruce beetles in south-central Alaska. MCH is naturally derived from female spruce beetles and is the primary antiaggregation pheromone used by the insect (Rudinsy 1973). Several studies have been performed using MCH and a pilot test using ground and aerial applications from a helicopter were done in 1991.

MCH was identified in 1974 as a major component of the spruce beetle pheromone. "Field tests have shown that granular formulation of MCH reduced attacks of spruce beetle on Engelmann spruce by 93 percent when trees were baited with MCH in Idaho," Werner says. "The addition of MCH to sticky traps baited with the natural attractant as well as synthetic pheromones suppressed attacks by spruce beetles in Lutz spruce on the Kenai National Wildlife Refuge by 87 and 99 percent respectively."

## A 5-year study plan

"We've had a real problem with spruce beetle infestations in south-central Alaska since 1974," Werner explains. "More that 1 million acres were infested. In 1986, outbreak level populations were found along the Yukon and Kuskokwim Rivers in interior Alaska where 160,000 acres had been infested. It was conceivable that the entire commercial spruce stands in the Yukon, Kuskokwim, and Tanana River Valleys could be killed."

The Yukon River Spruce Beetle Management Council was recently formed to work out strategies and solutions to this problem. The interagency council is developing and coordinating a program to evaluate the present and future impact of the spruce beetle on the environment of the residents and ecosystems of the lower Yukon River. A primary objective of the council is the development and application of preventive and suppression methodologies.

The 5-year project is a cooperative effort among FPM, Region 10, and the Institute of Northern Forestry in Fairbanks, Pacific Northwest Research Station.

"The primary purpose of the special project is to develop operational strategies for monitoring and manipulating spruce beetle populations," Werner says. "This will be accomplished by using semiochemicals in traps and on baited trees in interior and south-central Alaska."

The project is part of a larger international project involving the Forestry Institute, Forest Pest Management (Region 10), Forestry Canada, the University of Calgary, Simon Fraser University, and Phero Tech Corporation (an insect pheromone manufacturer).

Divided into two phases, the project addresses the development of new semiochemicals and the operational use of semiochemicals.

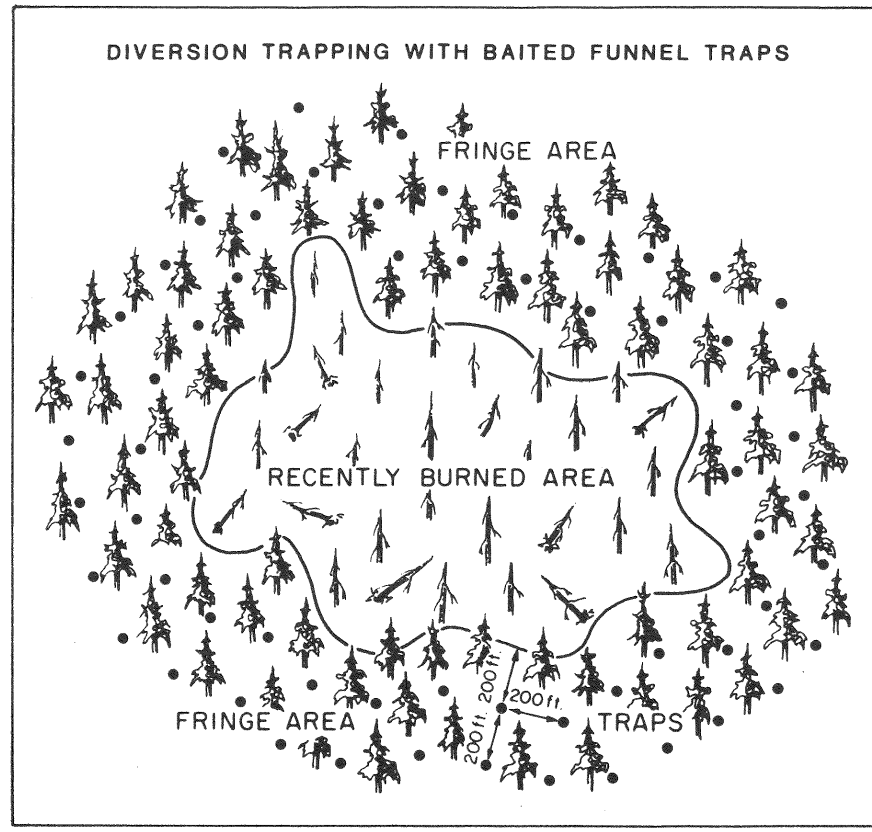
"Phase one occurred in 1988–1990 and dealt with the development of an improved pheromone blend for attracting spruce beetles. This phase included field tests on the effectiveness of the new formulations," Werner says. "The tests were conducted in northern and southern Alberta, British Columbia, and south-central and interior Alaska. Phase two will be in operation from 1991–93 and will demonstrate the efficiency of pheromone methods with improved formulations for manipulating spruce beetle populations in various management strategies."

The results of the first phase of the project resulted in several successes. Efficacy field trials were done on a new formulation of spruce beetle lure in stands of white

spruce at Bonanza Creek Experimental Forest in interior Alaska from 1988–89. "The lure was a ternary formulation which contained alpha pine, frontalin, and methylcyclohexenol (MCOL) compared to the current commercial lure produced by Phero Tech, which contains alpha pinene and frontalin," Werner explains. "The efficiency of this new lure was tested simultaneously against that of the commercial spruce beetle lure and proved superior by a wide margin. It attracted spruce beetles in much greater numbers in all areas of the field test."

Werner added that the new lure worked extremely well in Alaska in areas with endemic and epidemic beetle populations. "Trap captures as high as 1,500 per trap in 1 week were observed during peak flight in interior Alaska. The catches are attributed to the strong synergism for the components of the ternary bait," he adds. Final tests are being conducted in 1991.

For more information on pheromone research, contact Richard Werner at the Pacific Northwest Research Station, Institute of Northern Forestry, 308 Tanana Drive, Fairbanks, AK 99775–5500.




*Diversion trapping using baited funnel traps to remove beetles from fringe area surrounding a recent prescribed burn.*